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ANAPLASMOSIS IN CATTLE

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NATURE OF THE DISEASE

During recent years a disease known as anaplasmosis in cattle has been recognized in the United States. This malady resembles cattle-tick fever in many respects, and doubtless it has been confused with that disease in regions within tick-quarantine areas. It appears to affect only the bovine species.

Field investigations and a study of foreign literature indicate that anaplasmosis has probably been introduced into this country by carriers from tropical countries, and it doubtless has existed in the United States as long as tick fever. That it has now gained a serious foothold is shown by its prevalence in many localities.

In order to combat the spread of anaplasmosis and to eradicate it from sections already infected, a study of its nature, cause, means of transmission from sick to healthy animals, and other vital factors is being conducted by Federal and State scientists.[1]

Anaplasmosis is an acute, subacute, or chronic, febrile, infectious, protozoan disease, characterized by loss of flesh, labored breathing, suspension of milk flow, anemia, jaundice, and marked degenerative changes in the red blood corpuscles, owing to the activity of microscopic parasites, *Anaplasma marginale*. These minute organisms,

[1] Laboratory investigation, insect transmission experiments, field observations, and other lines of activity are being conducted by L. T. Giltner, under the direction of John S. Buckley, Chief, Pathological Division, and G. Dikmans and C. W. Rees, under the direction of Maurice C. Hall, Chief, Zoological Division. Likewise, similar work is being carried on at the Oklahoma Agricultural and Mechanical College, Stillwater, Okla., with C. E. Sanborn, entomologist, Harry W. Orr and Lewis H. Moe, veterinarians, cooperating with the author. Kansas authorities are also conducting investigations at Sedan, Kans., C. A. Pyle, in charge, on anaplasmosis with Federal aid. William H. Boynton and Karl F. Meyer are contributing valuable data on this subject from their studies in California.

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which destroy the blood cells, are transmitted from sick or "carrier"[2] cattle to healthy ones by the bites of insects. In foreign lands this malady is sometimes called gall sickness, because the bile bladder is usually much enlarged and its contents flocculent in appearance. Anaplasmosis may be confused with tick fever, but the latter is caused by a different microparasite, *Piroplasma bigeminum*, and is spread only by the bite of a tick, *Boophilus annulatus*, in the United States.

Anaplasmosis attacks mature cattle, rather than young animals. Calves under 1 year of age are seldom affected by the malady, and the cases that do occur are mild in character and death rarely follows. All breeds appear to be susceptible to the disease. Both native and imported animals are subject to attack. There may be but a common, barbed-wire fence between two herds of cattle apparently of the same age and kind, yet the disease may attack one herd and not the other. The malady prevails most during the warm summer and fall months, beginning in July and ending in October or November. Data from Oklahoma, however, indicate that an occasional case may be found every month of the year.

GEOGRAPHICAL DISTRIBUTION

Although anaplasmosis is classified primarily as a tropical or subtropical disease, being found in Brazil, Argentina, and other South American countries, in Central Africa and South Africa, the island of Formosa, the Philippines, Italy, and other European countries, it has been discovered in many sections of the United States including some areas having a cool climate. The malady is known to exist in Arizona, Florida, Louisiana, Texas, California, Nevada, Kansas, Oklahoma, and Missouri. It doubtless exists unrecognized in other States. Nevada and parts of several other States mentioned have low winter temperatures. The disease is thus not necessarily confined to warm climates, and its presence in other Northern States may be expected.

SYMPTOMS OF THE DISEASE

In the early stages of anaplasmosis a marked rise of temperature occurs, ranging from 105° to 107° F., but as the disease progresses the fever lessens. When the disease has fully developed, the temperature may drop to normal, later becoming subnormal before the animal dies. Many cases show a rapid, tumultuous heart action with a pulse rate from 80 to 140 a minute. On auscultation, a metallic ring to the heart sounds is detected. The breathing is accelerated and labored, respiration ranging from 50 to 60 a minute. Other symptoms are exhaustion, great debility, and suspended rumination. The skin, udder, teats, brisket, mouth, vagina, sclera of the eyes, and all visible membranes become yellow, anemic, and deathly pale. Pica, or depraved appetite, manifested by eating dirt or chewing bones, is sometimes observed. The animal may lie down frequently, and when walking, a stiff, weavy, unsteady gait is occasionally noted.

Urination is frequent and of a dribbling character. The urine, however, is rarely, if ever, bloody, as is the case with tick fever.

[2] A "carrier" is an animal which has recovered from an infectious disease, yet harbors the organism that caused the trouble within the fluids and tissues of the body. Such individuals may become active centers of new infection under favorable conditions.

Cerebral symptoms are rather common, and afflicted animals are disposed to fight. Muscular tremors of the neck, shoulders, or flank are often observed. The bowels are usually constipated, and the feces are dark in color and often blood-tinged and partly covered with mucus. Glandular swellings and a puffiness of the eyes may be noted, also a roughened coat. Abortion in advanced cases of pregnancy is somewhat common. Death may follow within 24 hours after the appearance of the first symptoms; however, the average fatal case usually lingers two or three days. Recovery takes place slowly, requiring many days or weeks before restoration is complete. (Fig. 1.)

ECONOMIC LOSSES

In addition to the direct loss of cattle by death from this disease, there is a further loss in the condition of flesh and the small size of

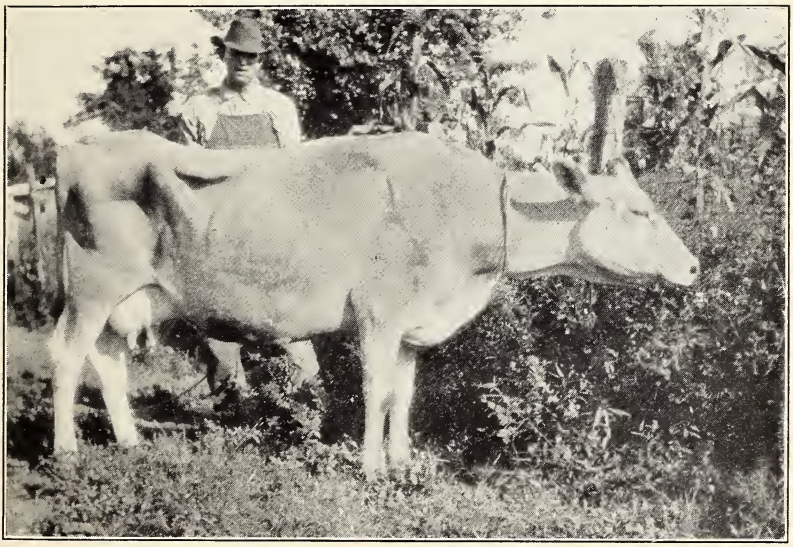

FIGURE 1.—A typical case of acute anaplasmosis. Note the gaunt appearance. This cow recovered

those animals that recover. This is noticeable in range cattle and younger animals which have become stunted. In dairy herds, milk production not only may be greatly reduced but sometimes fails completely until the following period of freshening. As already noted, anaplasmosis may also cause abortion, the fetus usually being expelled near the end of the gestation period during the acute onset of the disease.

DESCRIPTION OF THE PARASITE

The microparasite which causes the disease is generally found near the margin of the blood corpuscles, hence the name *Anaplasma marginale*. Figure 2 illustrates normal red and white blood cells of cattle, also the diseased corpuscles containing the parasites which cause anaplasmosis and tick fever.

The parasites, *Anaplasma marginale*, appear as small, dark objects in stained blood smears made from cattle sick of the disease. Although the parasites are usually seen in the margin of the blood cells, an occasional one may be observed in the center of the corpuscle. In the early stage of the disease, before the rise of temperature, the blood of cattle infected with anaplasmosis shows very few parasites. As the incubation period develops, the number of bodies increases, and with the onset of visible symptoms there is a marked increase in the number of red cells involved. At first the percentage of red cells invaded by the parasites may be below 1 per cent, but by the time the afflicted animal is plainly sick, the percentage of cells involved may have increased to 25 or even 50 per cent. Some cells may contain only one parasite, others two or three, and in exceptional cases, six, eight, or even more well-marked parasites may be present. After the disease has been observed one week or longer, there also appear in the blood large red cells which contain numerous granular

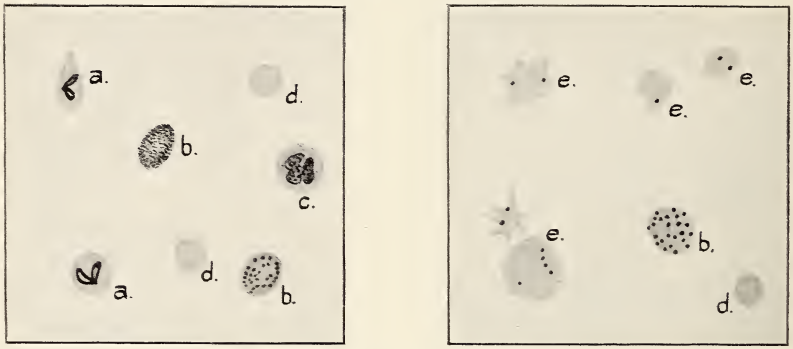

FIGURE 2.—Left, blood cells of a cow affected with tick fever: right, blood cells of a cow affected with anaplasmosis. (*a*) Red blood cells showing tick-fever parasites; (*b*) diseased red blood cells showing granules; (*c*) normal white blood cell; (*d*) normal red blood cells; (*e*) red blood cells showing parasites of anaplasmosis

bodies. Blood cells of this character also occur in cases of anemia from other causes.

When cattle are recovering from anaplasmosis, the number of cells involved by the parasites and the number of parasites in the blood gradually diminish until complete recovery is established. Unfortunately cattle that recover may become carriers, and their blood may remain infectious for long periods. Foreign investigators have demonstrated that cattle may harbor the parasites at least four years or longer after apparent recovery from the disease.

CHANGES IN AFFECTED RED CELLS

In the study of progressive changes occurring in the blood of cattle afflicted with anaplasmosis, very thin films of blood from living animals are spread on glass slides and treated with special aniline dyes. This process stains the red blood cell one color and the parasites another. When viewed under the microscope in the hands of trained observers, the causative organism can readily be discerned. The blood in normal, healthy cattle contains from 6,000,000 to

8,000,000 red cells per cubic millimeter.[3] In sick cattle this number is reduced to about 1,000,000 in the same quantity of blood. The invaded cells become thin and irregular in shape; other changes likewise occur which account for the thin, watery appearance of the blood. The hemoglobin, or color test, which in normal cattle may be 80 to 90 (Talquist scale), is often reduced in very sick animals to from 20 to 30. Mild infections may show a blood count of 2,000,000 to 3,000,000 red cells per cubic millimeter and a hemoglobin test of 40 to 50. The great diminution of red cells explains the pallor and anemia seen in cattle suffering from this disease.

FIGURE 3.—A typical, fatal case of anaplasmosis. The average mortality is about 40 per cent of the animals affected

MORTALITY

There is a wide range of mortality in outbreaks of anaplasmosis. Occasionally only a single death may be recorded in small herds of afflicted animals. (Fig. 3.) At other times the disease assumes a more deadly aspect, with a high percentage of sick cattle succumbing to the malady. The average mortality ranges from 30 to 50 per cent of the animals affected. There may, however, be considerable immunity where the disease has existed for some time, and this factor would influence the incidence of the disease and its mortality in such sections. The death rate is highest in sick animals showing a high proportion of the red cells; that is, when from 25 to 50 per cent of the cells are affected with the parasites. When the number of cells involved is not more than 5 to 10 per cent, the mortality is much less.

[3] A millimeter is approximately one twenty-fifth of an inch.

POST-MORTEM FINDINGS

Cattle dying of anaplasmosis usually succumb without violent struggling. Externally, there is no evidence of hemorrhage or injury. All visible mucous membranes and the skin show anemia and jaundice. Internally, the lymph glands are slightly enlarged, edematous, and watery in appearance without marked swelling or hemorrhagic appearance.

THORACIC CAVITY

The heart is usually enlarged, flabby, and its surface well sprinkled with petechiae (pin-point blood spots). Clots may be seen in the large blood vessels, manifesting themselves by long, ropy strings and masses. The blood is thin, watery, and light colored. The lungs are colorless and anemic and appear to be filled with air bubbles.

ABDOMINAL CAVITY

The liver is usually enlarged, and hemorrhagic areas may be noted on its surface. When incised, this organ appears to be saturated with bile. The bile bladder is greatly distended and contains a viscid, thick, flocculent, dark-green, gelatinous fluid.

Externally, the kidneys may appear normal, aside from a tinge of yellow discoloration. Internally, slight congestion may be noted.

In most cases the spleen is enlarged, the pulp is softened, dark colored, resembles blackberry jam, and is degenerated. An occasional case may fail to show the splenic enlargement. The average spleen of an adult healthy cow weighs about 1¼ pounds. The spleen from one diseased cow examined weighed 7 pounds.

The urinary bladder usually shows a considerable quantity of dark, straw-colored fluid, which often contains traces of bile and sugar. An occasional pin-point hemorrhage is noted on the inner walls of the bladder.

The gastrointestinal tract shows nothing characteristic; however, the third stomach is usually somewhat drier than normal.

Dry, hard masses of feces are often seen in the large bowel; they may be streaked with a bloody mucus, indicating a catarrhal enteritis.

GENERAL

The entire internal structure, including muscle, fat, connective tissues, marrow, brain, and other organs usually show a yellow discoloration.

DIFFERENTIAL DIAGNOSIS

Within quarantine areas anaplasmosis may be confused with tick fever. In the latter disease, bloody urine is always present, while in the former it is rarely or never present. Microscopic examination of the blood should disclose parasites characteristic of either disease. The presence of the tick-fever tick, together with bloody urine, would indicate splenetic fever. Experimentally, and in nature, cattle exposed to tick-fever ticks show symptoms of the disease within 8 to 14 days. In anaplasmosis, the incubation period is longer. The results of experimental inoculations, made by the writer, show that adult cattle can be successfully inoculated experimentally, while

younger animals are less susceptible to such injections. Artificial inoculation of small quantities of blood from cases of anaplasmosis requires from 20 to 40 days to develop the disease, according to the size of the dose. According to some observers the period of incubation may extend to 100 days.

Anaplasmosis may be erroneously diagnosed as anthrax, largely because the spleen is abnormal in appearance. Cultures, microscopic examinations, and animal inoculation should enable veterinarians and laboratory workers to make a correct diagnosis.

In hemorrhagic septicemia the profound changes of the blood are not present as in anaplasmosis; the lymphatic glands are engorged and enlarged; the lungs are deeply congested; and other changes may be noted. A positive diagnosis may be made by growing the bipolar organism, followed by serological tests and animal inoculations.

In simple gastrointestinal disorders the illness would probably be of short duration and not fatal. Forage poisoning would show a subnormal temperature, paralysis of the throat, and other symptoms of that illness.

ANAPLASMOSIS FOLLOWING DEHORNING

As evidence of mechanical transmission of this disease, in addition to blood inoculation, already mentioned, numerous outbreaks have occurred following dehorning, where proper cleanliness and surgical precautions were not observed. Thirty-five cases of anaplasmosis, following dehorning, were found by the writer in one herd (fig. 4), and several other outbreaks were traced to the same means of spreading infection. The disease was spread apparently by unclean saws or other dehorning devices. Illness usually appeared from 35 to 40 days after the operation. One investigation showed that two cases of the disease developed among seven cows dehorned. One cow died, the other recovered. One of the seven cows was definitely proved to be a carrier, and the two cows which developed the disease had been dehorned immediately after the carrier cow.

Important precaution.—In view of the evidence now available, it is highly important that all saws or other dehorning devices should be properly cleaned and disinfected before dehorning each animal in localities where anaplasmosis is known to exist. The same precautions should be observed in sterilizing hypodermic syringes and needles used in treating anaplasmosis, testing for tuberculosis, or other veterinary practice, in order to prevent artificial transmission of disease from unclean instruments.

PROBABLE MEANS OF TRANSMISSION

Investigators in foreign countries have studied various insects and ticks with reference to the transmission of anaplasmosis. The consensus of opinion among those scientific workers incriminates ticks as the pest most likely to be involved in this process. Notwithstanding the evidence from abroad, in the United States there is probably more than one carrier responsible for the transmission of anaplasmosis; hence the necessity of properly controlled experiments to determine these important questions.

TICKS

Since anaplasmosis resembles tick fever in many respects, it is natural to consider ticks as the possible carrier in spreading anaplasmosis. In the United States, anaplasmosis has frequently been found outside the area quarantined for splenetic, southern, or tick fever, and it is evident that the transmission of the disease outside the quarantined area is not due to the cattle-fever tick. Scientists have demonstrated that at least eight different kinds of ticks are factors in the spread of anaplasmosis under experimental conditions. The blue tick (*Boophilus decoloratus*), the black tick (*Rhipicephalus simus*) the brown dog tick (*Rhipicephalus sanguineus*), the castor-bean tick (*Ixodes ricinus*), the sheep tick (*Boophilus micropilus*), the tropical cattle tick (*Boophilus australis*), also *Rhipicephalus bursa*

FIGURE 4.—Cattle recovering from anaplasmosis following dehorning. The animals were chiefly steers and heifers, 2 and 3 years old. Of 340 animals dehorned, 35 contracted the disease and 13 died of anaplasmosis. The outbreak occurred 42 days after the operation

and *Hyalomma lusitanicum*, have been proved to be capable of transmitting anaplasmosis. During 1930 Dr. C. W. Rees, of the Bureau of Animal Industry, incriminated *Rhipicephalus sanguineus* as one carrier of anaplasmosis in the United States. This was the first time that this tick had been shown to be a carrier and the first time that any tick had been convicted as a carrier of anaplasmosis in this country. Presumably *Boophilus annulatus* also is a carrier. Evidence obtained from leading entomologists of this country indicates there are at least 50 known species and varieties of ticks in the United States. Fortunately all these ticks are not found in every locality, especially where anaplasmosis prevails.

A detailed and comprehensive study of the factors incident to tick life will be necessary before the problem of anaplasmosis can be completely solved.

FLIES

A popular belief prevails that flies of some kind are responsible for the spread of anaplasmosis. The writer has demonstrated the presence of microparasites resembling Anaplasma in the abdominal contents of tabanids (large horseflies) for a period of 16 hours after the flies had fed on cattle sick with anaplasmosis. Anaplasmosis reaches its height in prevalence during the fly season; however, sporadic outbreaks of the malady, particularly during the early spring season, months after flies have become inactive, tend to disprove the fly theory. Again, many instances have been observed in which cattle sick with anaplasmosis were severely tormented by flies of all descriptions, yet the disease was confined to only a few animals in large herds. One experiment with *Tabanus sulcifrons* conducted at the Oklahoma Agricultural Experiment Station during August, 1929, when 12 flies were known to have bitten both a cow sick with anaplasmosis and a healthy one, failed to transmit the disease after nine months' observation. This cow was then injected with virulent blood from an anaplasmosis carrier and died during July, 1930, thus proving that she was susceptible to the disease. Foreign literature indicates that fly experiments thus far recorded were negative.

MORE RESEARCH NECESSARY

Experiments conducted under properly controlled conditions with ticks, flies, mosquitoes, and other insects are desirable to fix definitely the identity of the carriers of the infection. Adult cattle from herds known to be free from disease should be used for experiments. They must be sprayed or dipped before artificial infection, and kept in screened sheds. Such experimental animals must be fed, watered, and cared for by competent help, and must be held under observation for long periods of time. Temperature readings, blood smears, red-cell counts, and hemoglobin tests are necessary.

TREATMENT

The treatment of cattle sick with anaplasmosis is still in the experimental stage and largely a veterinary problem; however, the owner can assist to some extent. Animals afflicted with the malady should be kept in the shade, given plenty of clean water and a little green feed, and protected against fly annoyance. Good care is essential in helping animals to resist the disease. Unnecessary driving or rough handling of sick cattle may hasten their death. A veterinarian should be called at once. Delay may result in the death of sick animals.

Many owners attempt to administer salts, linseed oil, or other substances by drenching. Too often serious results follow, because the drugs given enter the lungs, and the treated animal dies from pneumonia caused by mechanical injury. As most cattle sick with anaplasmosis are constipated, the use of saline purges or other cathartics to flush the bowels is ordinarily indicated, but the dose should be moderate in order to prevent too drastic an effect.

Medicated mineral oil or mild cathartics should be of value and without danger to the animal. Since the disease is caused by parasites destroying the red blood cells, most veterinarians inject intra-

venously some form of arsenical preparation with the expectation of destroying these parasites. Among the many products available on the market is sodium cacodylate. This drug is either purchased in ampule form or prepared by the veterinarian himself. The writer has observed serious abscess formation following the injection of this drug into the muscle tissues or under the skin; consequently, it should be injected into a vein to avoid this complication. The use of germicides and proper asepsis and technic in making these injections must be observed to avoid phlebitis and other difficulties. The value of this drug, however, has not been demonstrated by well-controlled experiments with untreated sick animals as controls. In some herds the mortality has been very high even when sodium cacodylate was used in large doses.

Stimulative treatment with injections of camphorated oil, or strychnine, may be indicated to support the heart action. Should hemorrhagic septicemia also be present in afflicted herds, the use of biologics may be advantageous.

SUMMARY

Anaplasmosis is an infectious disease of cattle that has gained a foothold in many parts of the United States.

Losses in affected herds may be severe, averaging as high as 40 per cent of the animals affected, and animals that recover may be stunted and in poor condition for a long period. Milk production in dairy cattle sometimes fails completely, and abortion frequently occurs in affected cows.

The microparasite causing the disease can be transmitted from sick or carrier cattle to healthy ones by means of certain ticks or by veterinary instruments. The possible transmission of the disease by means of flies and other insects is a subject that needs further research. Experiments conducted under properly controlled conditions are necessary in order to fix definitely the responsibility of the carrier.

The attention of cattle owners is especially directed to the fact that the disease often follows dehorning when proper cleanliness and surgical precautions are not observed. In localities where anaplasmosis is known to exist, extreme care should be taken to clean and disinfect saws and other dehorning devices before dehorning each animal. The same precautions are necessary in sterilizing instruments used in tuberculin testing or other veterinary practices.

Anaplasmosis may be confused with other diseases, especially tick fever in the quarantined area. In some respects anaplasmosis resembles anthrax, hemorrhagic septicemia, and other less serious disorders.

Treatment for anaplasmosis is still in the experimental stage and is largely a veterinary problem. Cattle owners may help sick animals to recover by giving them extra care and avoiding unnecessary driving or rough handling.

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